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Fiery Rose

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Fire imagery can be one of the most spectacular phenomena when different factors come into play. Many pictures have been taken of fire, so adding variables to the fire can transform the ordinary image of fire to an extraordinary image. By freezing objects in liquid nitrogen before placing them in fire, uncommon heat transfer effects can be observed through the dichotomy of hot and cold. The object can be placed in the fire for long periods of time without being charred from the fire. Normally, an object is put in a fire to burn, but seeing items in fire that are seemingly untouched by the flames provide great imagery. With the help of Gabriel Paez, an apple, a pear, and numerous roses were frozen in liquid nitrogen and placed in fire to see how each item would react in the flames.

To setup the experiment to photograph effectively, precautionary measures were taken to ensure that everyone involved was safe by following The Combustion Experiment Guidelines. Also, since the fire was burning in a pit close to an expensive black backdrop, bricks were stacked up around the fire to ensure that it did not spread. After safety precautions were taken, the rose was allowed to sit in liquid nitrogen for about one minute to make sure it was completely frozen. The rose was then grabbed with tongs and placed in the fire with the petals facing the photographer. At this point, many photographs were taken of the phenomenon. The experimental setup can be seen in Figure 1 below.

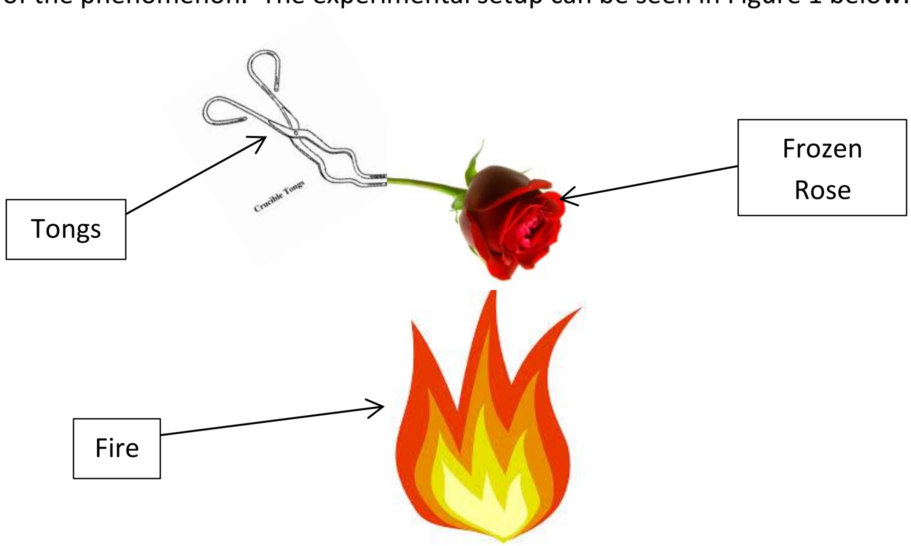

Figure 1: Experimental Setup Side View

When the rose is held in the fire, heat from radiation, conduction and convection act on the rose to heat it up from its frozen state. Figure 2 below gives a visual representation of the heat transfer occurring in the experiment [1]. Conduction occurs when objects come into contact with each other and the warmer object provides heat to the cooler object. Convection occurs when a moving fluid acts to heat or cool another object. Thermal radiation is heat transfer that interacts with an object through moving particles [2]. In this way, Convection and radiation heat from the fire warm the rose while at the same time conduction occurs between the contact point of the tongs and the rose to further heat the rose. Due to conservation of energy, the fire's heat gets dispersed into the atmosphere and absorbed by everything else around it. In this case, that includes the bricks, the ground, people around the fire, the rose, and the tongs.

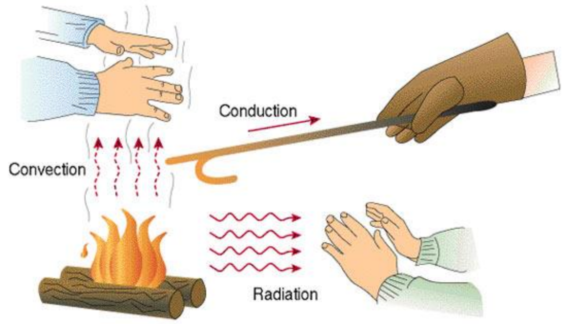

Figure 2: Heat Transfer Diagram

Amazingly, the rose stayed cold for a good period of time. After about 30 seconds of being in the fire, the rose finally displayed signs of burning. The rose does not burn because it needs to heat up to a certain temperature to actually become charred and ignite. Paper, for example, needs to be heated to 451 degrees Fahrenheit to burn. Since the rose is initially at such a low temperature when it is frozen by the liquid nitrogen which has a boiling temperature of -321 degrees Fahrenheit [3], it takes much longer for the conduction, convection, and radiation to heat the rose to its burning temperature. Thus, the rose can stay in the fire for long periods of time until it heats to its critical burning temperature to visually appear burnt.

To freeze the rose, liquid nitrogen was rented from the University of Colorado. Some liquid nitrogen was poured into a Styrofoam cooler before the rose was placed into the cooler with it. The outside temperature during the time of the experiment was about 60 degrees Fahrenheit so the liquid nitrogen evaporated fairly quickly. As a result, the fire was ignited and ready before freezing the rose to ensure the most efficient use of the liquid nitrogen. The picture was taken just after sunset at around 7:45 P.M. when it was dark outside and the black backdrop behind the fire pit provided a black background as well. Since the fire provided ample lighting, no flash was used on the camera. Using a flash would take away from the details of the flames. The picture chosen was taken after the rose was held for about 10 seconds in the flames.

The field of view in the original image, seen below in Figure 3, is about 16 inches in width and 12 inches in height. The photograph was taken with a Samsung ST65 digital point-and-shoot camera at a similar height as the rose and about 18 inches away horizontally from the rose to the lens. I was fairly close to the rose and flames to fully capture the details of the rose. In the picture, a white frost on the outside of the rose can be seen as a result of dipping it in liquid nitrogen. The lens focal length was 13.2 millimeters, the exposure time was 1/60 seconds, the ISO setting was 230, the aperture was 3.4, and the F-stop number was f/3.9. These values allowed the camera to capture the details of the flames without letting in too much light from the fire. In pixels, the original image was 4224 in width by 2816 in height. In contrast, the final image was 2616 pixels in width and 1498 pixels in height after being cropped.

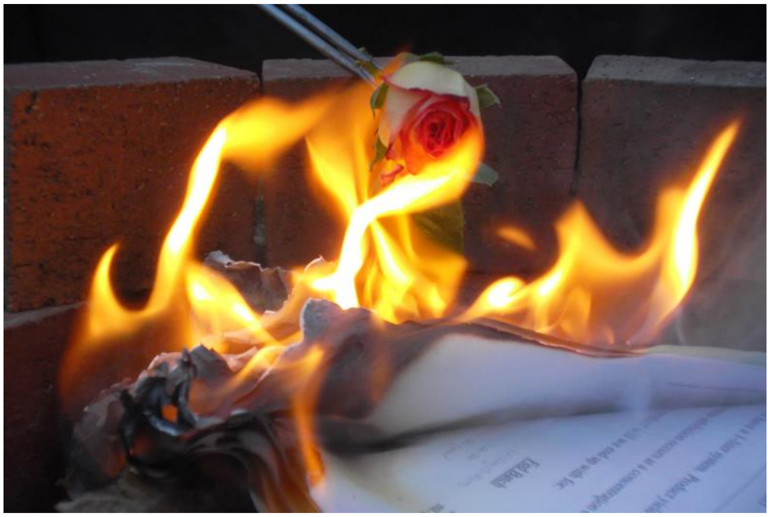

Figure 3: Unedited Image

The original picture was cropped to size in Photoshop to highlight the rose in the picture and omit the burning paper and ash from the fire to create the final image shown in Figure 4. Using the Curves Tool in Photoshop, the details of the flames were brought out by adding slight contrast to the image. Also, the tongs were edited out in Photoshop to make the rose appear as if it floats in the fire.

Figure 4: Edited Image

Overall, the image depicts the heat transfer between a very cold object and a very hot object. It proves that even fire's mighty heat takes time to affect freezing objects. In the image, I like how the flames wrap around the rose while the white frost on the outer surface of the petals can still be seen. It displays the dichotomy of cold versus hot opposites. To improve the experiment, the temperature of the rose could have been taken before being placed in the fire and at short intervals after being placed in the fire using a thermocouple or infrared thermometer. Also, the exact time it took for the rose to start burning could have been recorded. From this information, thermal constants could have been derived with some calculation. This would have allowed for a more accurate calculation of the heat transfer from the fire to the rose. Ultimately, I like how the image turned out because it gives the viewer a good feel for the contrast between cold and hot and displays great properties of heat transfer.

References

[1] "Heat Transfer – The Basics." *Roaster Project RSS*. N.p., n.d. Web. 02 Apr. 2013.

[2] "Heat Transfer." *Wikipedia*. Wikimedia Foundation, 04 Feb. 2013. Web. 02 Apr. 2013.

[3] "Liquid Nitrogen." *Wikipedia*. Wikimedia Foundation, 29 Mar. 2013. Web. 02 Apr. 2013.